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Research on the influence of mold temperature on the quality of 5-blade fan products

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Abstract
Plastic molding is a manufacturing process for plastic parts based on the shaping method. The plastic molding process involves heating the raw plastic material, injecting this plastic flow into the mold cavity, and ending when the plastic product solidifies and can be removed from the mold. To ensure the accuracy of the geometric shape as well as the strength of the product, it is necessary to create stability in the temperature of the molten plastic flow during the injection into the mold cavity. One of the factors directly affecting the stability mentioned above is the mold temperature. The authors focused on finding the optimal mold temperature to ensure the best quality of plastic fan products. Through the application of simulation method using Moldex3D software, the results obtained clarified the effectiveness of each mold temperature milestone on the part and provided the optimal mold temperature.

Keywords: *Mold temperature, Plastic injection mold, Plastic fan blades, numerical simulation.*

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I. PLASTIC INJECTION MOLD SYSTEM FOR 5-BLADE FAN

The field of engineering mold technology is one of the industries receiving significant investment and development attention in our country. Currently, there is an immense demand for products made from plastic. This necessitates production lines that ensure productivity, quality, and product stability. The plastic injection mold system for the detail of a 5-blade fan was studied and calculated by the author group according to standards, with achieved results as shown in Figure 1.

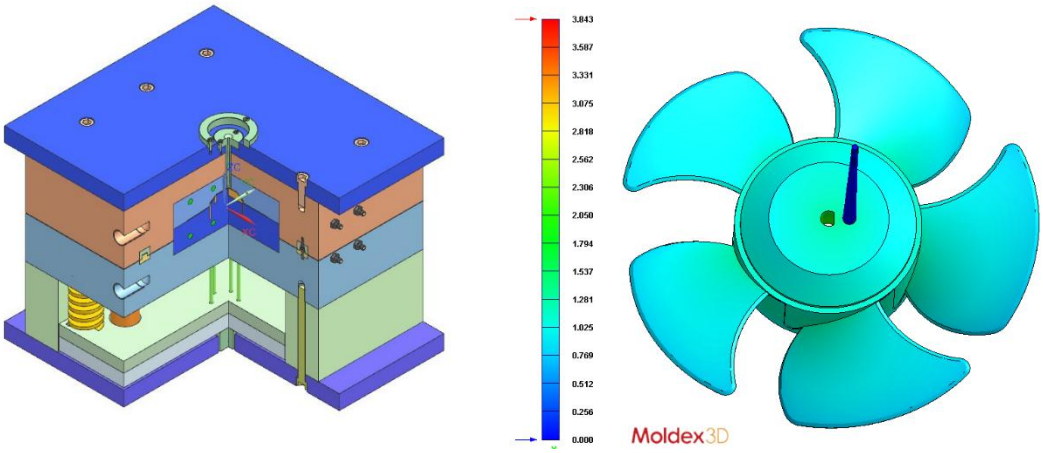

Figure 1. Mold of plastic injection mold and surface depression defect of 5-blade fan detail

The mold temperature influences the shape and quality of the product. A higher mold temperature can improve the fluidity of the plastic. However, it can lead to some defect such as [1]:

Excessively high mold temperature causing sink marks due to uneven cooling; the product exhibits wrinkles and waves.

Excessively low mold temperature resulting in plastic shortage as the plastic solidifies before filling the detail completely.

II. SUMILATION AND OPTIMIZATION OF THE PRODUCT

The research project aims to determine the optimal mold temperature in the plastic injection molding process of a 5-blade fan product. The method utilizes Moldex3D software to simulate the plastic filling process in the mold. Based on the simulation results from the software, charts are generated and the influence of mold temperature on the product is evaluated.

2.1. Input paremeters

Simulate on Moldex3D software with parameters as listed in Table 1

Table1. Input parameters

Plastic Melting Temperature: 240°C	Mold-Open time: 5 seconds
Filling time: 1 second	coolant temperature: 25°C
Packing time: 10 seconds	Coolant flow rate: 50cc/s
Cooling time: 12 seconds	Mold temperature: 50°C to 90°C

2.2. Simulation Results

The results of analyzing the influence of mold temperature on product quality (using Moldex 3D software similation) are presented in Table 2.

Table2. Simualtion Results

Mold temperature (°C)	Max packing sinkmark displacement ($x10^{-2}$ mm)	Max packing volumetric shrinkage (%)	Max warpage total displacement (mm)	Max warpage volumetric shrinkage (%)
50	4.2134	6.2823	0.5387	3.8497
55	4.2115	6.2800	0.5386	3.8504
60	4.2234	6.2764	0.5389	3,8670
65	4.2634	6.3344	0.5386	3.9060
70	4.2111	6.2806	0.5382	3.8443
75	4.2101	6.2832	0.5381	3.8380
76	4.2123	6.2818	0.5374	3.8425
78	4.2112	6.2829	0.5372	3.8422
80	4.2104	6.2835	0.5372	3.8432
82	4.2230	6.2829	0.5381	3.8653
84	4.2153	6.2846	0.5377	3.8498
85	4.2155	6.2851	0.5376	3.8495
90	4.2237	6.2763	0.5391	3.8673

Comparison chart of simulation

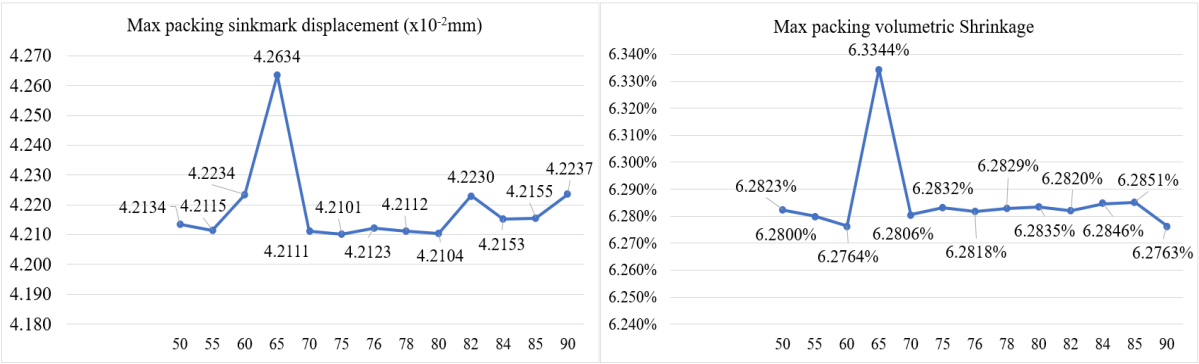

Figure 2. Comparison of Shrinkage and Deformation in the Compression Process

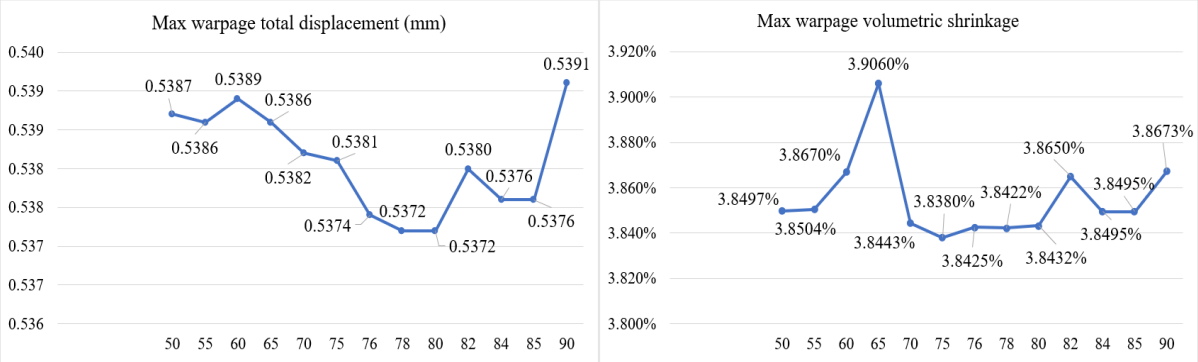

Figure 3. Comparision of Shrinkage and Deformation after Compression

Comments:

Max packing sinkmark displacement chart: At a mold temperature of 65°C, the highest surface depression result is obtained (4.2634x10-2mm). The best simulation results are achieved at mold temperatures of 75°C and 80°C

Max packing sinkmark displacement chart: The highest shrinkage at a mold of 65°c is observed (6.3344%). The lowest shrinkage result is obtained at a mold temperature of 90°C (6.2763%).

Max warpage total displacement chart: The least warpage is observed at mold temperatures of 78°C and 80°C (0.5372mm). The highest warpage is observed at a mold temperature of 90°C (0.5391 mm).

Max warpage volumetric shrinkage chart: The lowest shrinkage is observed at 75°C (3.8380%). The highest shrinkage is observed at a mold temperatures of 65°C (3.9060).

The optimal tempareture is achieved at 78°C and 80°C.

III. CONCLUSION:

The research project has provided results on product quality after varying mold temperatures, saving time and costs compared to real-word experimentation.

By applying the knowledge from this research, production processes can be optimized to increase efficiency and reduce costs.

This research project proposes a design solution for plasitc injection molds, which could serve as theoretical foudations for designers to refer to during mold design calculations.

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